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STUDIES ON COMPARATIVE ANATOMY OF GOATS AND DAIRY COWS 1/

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Except for reports relating to the reproductive organs and the udder, there is little information on the anatomy of the goat. Ormiston and Touchberry (4) 3/ measured height at withers in studies of the effects of inbreeding on the growth and milk yield of French Alpine goats. Leeuwen (3) described relationships between milk production and the general appearance, the udder, and the bones of milk goats. In studies of some 30 body measurements and external characteristics, Gruningen (2) found that milk yield was correlated to some degree with such general characteristics as rib position, smallness of flank, shallowness of thorax, fineness of skeleton, thinness of hair cortex and thinness of skin. Florentin (1) gave a general description of the anatomy of the sheep and goat. Stanton (7) discussed the digestive processes and referred to the comparative size and position of the parts of the digestive organs but gave no specific data. Reetz (5) made an intensive study of the gross and microscopic structure of the third stomach of cattle, sheep, and goats. None of these workers, however, showed actual differences in the body form or in the weights or measurements of the internal organs. Furthermore the goat was omitted entirely in descriptions of the anatomy of the domestic animals by Sisson and Grossman (6).

A comparative anatomy of the goat and the dairy cow seems particularly pertinent because the goat, one of the smallest ruminants, has been extensively used in pilot studies of physiology and lactation that could apply to similar studies of cows.

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1/ Cooperative investigations of the Agricultural Research Service, U. S. Department of Agriculture, and the New Mexico State College of Agriculture and Home Economics.

2/ Retired (formerly research dairy husbandman) and research dairy husbandman, respectively, Dairy Cattle Research Branch, Animal Husbandry Research Division, A.R.S., U.S.D.A.

3/ Underscored figures in parentheses refer to Literature Cited at end of publication.

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In 1937, at the New Mexico Station, studies were begun of the external body form and internal anatomy of female goats similar to studies then in progress with dairy cows at Beltsville, Md. Measuring instruments from U.S. Department of Agriculture were loaned to the station and instructions of procedure and data forms were provided. Copies of the data obtained were submitted to the Dairy Cattle Research Branch.

Before a goat was removed from the herd, approximately 30 measurements of its body form were obtained. The goat was then slaughtered according to customary butchering procedures. Virtually all of the internal organs and glands were weighed or measured. Measurements were made of the dimensions of the chest cavity, of the suspended carcass, and of the trachea. The udder, the hide, and the dressed carcass were weighed and the dressing percentage calculated. Empty body weight, the difference between the live weight immediately before slaughter and the weight of the contents of stomach and intestines, was determined for each animal.

Detailed ante mortem and post mortem data were obtained for 14 female goats that were either purebred Toggenburgs or grades with at least 15/16 Toggenburg inheritance. At least one lactation record of milk and butterfat production was available for each goat. Body weights ranged from 88.25 to 140 pounds, with an average of 111.29 pounds.

During contemporary studies at Beltsville, corresponding ante mortem and post mortem data were obtained for 185 Holstein and 194 Jersey cows, measured and slaughtered according to the same plan. The comparison of results of goats with cows is important since both are ruminants and used commercially in milk production.

To date (1966) corresponding ante mortem and post mortem data have now been summarized for the 185 Holstein and 194 Jersey cows slaughtered according to the same plan at Beltsville. The ranges and averages for age at the time of slaughter were nearly the same for the goats as for the Holstein and Jersey cows as shown in table 1.

One or more records of milk and fat production had been completed on each of the goats. The records were reported on the basis of two milkings daily for 305 days. The number of lactation records reported for each animal ranged from 1 to 12, with an average of 4.2. In evaluating productive capacity, the highest actual production made by an animal in any one lactation of 305 days was used. Production averages for goats of different ages at slaughter are shown in table 2.

#### COMPARISONS OF THE EXTERNAL BODY FORM

Comparisons of the mean body measurements (ante mortem) of the Toggenburg goats from New Mexico with those of Holstein and Jersey cows from Beltsville are shown in table 3. In addition to the three sets

TABLE 1.--Comparative ages of Toggenburg goats and Holstein and Jersey cows at time of slaughter

Animals	Aged slaughtered					
	Average age		Youngest		Oldest	
	Year	Month	Year	Month	Year	Month
Goats	7	6	3	2	14	4
Holsteins	6	11	2	11	15	3
Jerseys	7	2	2	11	15	6

TABLE 2.--Production record of goats for highest lactation period of 305 days

Age	Number	Production	
		Milk	Butterfat test
		<u>Pounds</u>	<u>Percent</u>
More than 4 years, average 5 years	6	1,727	4.08
Under 4 years, average 2 1/3 years	8	1,413	3.96
Average 3 1/3 years		1,548	4.02

of means, each measurement mean for goats is expressed as a percentage of the corresponding measurement mean for Holstein or Jersey cows. For the sake of clarity in the following discussion, these computed values are referred to as percentages or percentages of Holstein and Jersey values. Body weight and hide thickness, although not measurements of body dimension, are included with this group of characteristics. The goat measurements consistently produced higher percentages from Jersey data than from Holstein data because Jerseys were smaller than Holsteins.



TABLE 3.--A comparison of the weight and body measurements (ante mortem) of female Toggenburg goats with those of Holstein and Jersey cows

Item of measurement	Average measurements						Values per 100 cm. of wither height					
	Toggenburg goats			Jersey cows			Toggenburg goats			Jersey cows		
	Ratio of Toggenburg goats to: Holstein cows			Ratio of Toggenburg goats to: Jersey cows			Ratio of Toggenburg goats to: Holstein cows			Ratio of Toggenburg goats to: Jersey cows		
	6-11	7-2		6-11	7-2		6-11	7-2		6-11	7-2	
Age.....yr.-mo..	7-5			6-11	7-2							
Body weight.....lb.	111.29	1,343.00	1,001.00				0.083	0.111		0.157	0.191	
Height, withers.....cm.	72.19	136.57	124.18				.529	.581		1.000	1.000	
Height, hips.....cm.	71.61	137.22	122.89				.522	.583		.987	1.002	
Height, pinbones.....cm.	60.24	131.56	120.65				.458	.499		.866	.859	
Height, back.....cm.	71.25	134.82	120.36				.529	.592		1.000	1.018	
Length, withers - hips.....cm.	46.76	97.97	87.22				.477	.536		.903	.922	
Length, hips-pinbones.....cm.	17.34	46.55	45.13				.373	.384		.705	.661	
Length, withers-pinbones.....cm.	64.10	144.17	132.03				.445	.486		.841	.835	
Length, shoulder-pinbones.....cm.	72.26	169.94	155.09				.425	.466		.804	.802	
Length, loin.....cm.	25.35	39.14	35.94				.648	.705		1.225	1.214	
Length, rump.....cm.	21.84	40.49	38.77				.539	.563		1.020	.969	
Depth, fore chest.....cm.	33.74	74.69	68.97				.452	.489		.855	.842	
Depth, rear chest.....cm.	33.62	75.10	69.31				.448	.485		.847	.834	
Depth, paunch.....cm.	34.80	75.78	70.04				.459	.497		.869	.855	
Width, fore chest.....cm.	19.34	47.40	40.57				.403	.477		.772	.820	
Width, rear chest.....cm.	26.27	62.12	56.30				.423	.467		.800	.803	
Width, paunch.....cm.	29.37	66.82	62.17				.440	.472		.831	.813	
Width, loin.....cm.	12.02	37.92	33.34				.317	.361		.600	.620	
Width, hips.....cm.	17.52	56.63	51.06				.309	.343		.585	.590	
Width, thurls.....cm.	18.68	52.27	43.91				.357	.425		.676	.732	
Width, pinbones.....cm.	13.25	39.13	31.01				.339	.427		.640	.735	
Circumference, fore chest.....cm.	88.55	199.55	180.76				.444	.490		.839	.843	
Circumference, rear chest.....cm.	97.56	223.46	205.13				.437	.476		.826	.818	
Circumference, paunch.....cm.	104.54	233.27	216.70				.448	.482		.848	.830	
Length, poll to mouth.....cm.	21.92	54.63	47.57				.401	.461		.759	.792	
Width head (eye level).....cm.	13.34	23.93	22.50				.558	.593		1.055	1.020	
Circumference, muzzle.....cm.	24.01	51.51	45.31				.466	.530		.882	.911	
Circumference, shinbone.....cm.	8.93	18.95	16.19				.471	.552		.891	.949	

The percentages for body weight, a measure representing mass, did not fall within the same range of percentages as the measures of linear dimension. For example, percentages of Holstein and Jersey values, respectively, were only 8.3 and 11.1 for body weight, whereas the percentages for body measurements ranged from 30.9 for width of hips in relation to Holstein data to 70.5 for length of loin in relation to Jersey data.

Percentages of Holstein and Jersey values for four body heights of the goats averaged 50.9 and 56.4, respectively. These were the highest average percentages for any group of body measurements. In this group, however, percentages for height at pinbones were definitely lower than those for the other heights.

Average percentages of Holstein and Jersey values for six body lengths of the goats were 48.4 and 52.3, respectively. Among the measurements in this group, percentages for length hips to pinbone (37.3 and 38.4, respectively) were noticeably lower than the rest, and percentages for length of loin (64.8 and 70.5, respectively) were noticeably higher than the rest.

Next in order of magnitude were the average percentages of Holstein and Jersey values of 45.3 and 49.0, respectively, for three body depths and 44.3 and 48.1 for three body circumferences. Percentages were quite similar for all items within each of these groups. Average percentages of Holstein and Jersey values, respectively, were 42.3 and 47.2 for body widths of fore chest, rear chest, and paunch, but only 31.7 and 36.1 for width of loin.

The relatively narrow pelvic dimensions in the goats were shown by average percentage of Holstein and Jersey values of 33.5 and 39.9, respectively, for widths of hips, thurls, and pinbones. The lowest percentages among the pelvic widths were for width of hips.

Percentages for circumferences of shinbone and muzzle were at about the same magnitude as those for body lengths. Percentages for head width were among the highest of any body measurements, but percentages for head length were comparatively low. Thickness of the hide in the goats was only 36 and 41 percent of the hide thickness in Holstein and Jersey cows, respectively.

Although rump length, as measured from point of hip to point of pinbone was comparatively high, with 53.9 and 56.3 percentages of Holstein and Jersey values, the somewhat parallel dimension, length hips to pinbones, with percentages of 37.3 and 38.4, was comparatively low in the goats. This difference is accounted for by the different position of the pelvis and the resulting low position of the pinbones in the goats.

Height at withers often is considered one of the basic measurements of skeletal size. Further comparisons of the means for goats with the means for Holstein and Jersey cows were made on the basis of the number of

units of a weight or measurement per 100 centimeters in height at withers. These values provide a common denominator for comparisons and also direct attention to the relative rather than the actual magnitude of the different body dimensions. Differences in relative body dimensions may more easily be evaluated when shown as ratios of goat values per 100 centimeters of wither height to the corresponding values for Holstein and Jersey cows. Ratios above 1.0 indicate that the dimensions were greater, in relation to height at withers, in the goats than in Holstein or Jersey cows. Likewise, ratios below 1.0 indicate that the dimensions were relatively lower. The values per 100 centimeters of wither height and the relation of Toggenburg goats to Holstein and Jersey cows are shown in table 3.

Groups of body measurements had nearly the same rank by these ratios of goat values to Holstein and Jersey values as they did by average percentages of Holstein and Jersey values. Averages of these ratios to Holstein and Jersey units per 100 centimeters of wither height were 0.951 and 0.960 respectively for heights of back, hips and pinbones, 0.916 and 0.901 for six body lengths, 0.857 and 0.844 for body depths, 0.838 and 0.830 for body circumferences, 0.801 and 0.812 for widths of fore chest, rear chest, and paunch, and 0.634 and 0.686 for width of hips, thurls, and pinbones. Ratios were low for head length (0.759 and 0.792), but comparatively high for head width (1.055 and 1.020). These ratios emphasize particularly the existence in goats of a proportionally tall, long body, which is definitely narrow particularly in the region of the pelvis, and a short, wide head as compared with Holstein and Jersey cows.

#### BODY PROPORTIONS, RATIOS, AND INDEXES

A number of body characteristics of the dairy cow can be expressed most clearly as relationships between certain body measurements. "Wedge shape" has long been emphasized as indicative of dairy character and body capacity in the dairy cow. Wedge shape is expressed in three ways: Depth, width, and circumference. Wedge shape in depth is calculated by dividing the depth at the paunch by the depth at the fore chest and the result expressed as a ratio. Similarly, wedge shape in width and in circumference are calculated from the measurements of width and circumference, respectively.

Thoracic index, which shows the relation of depth to width of fore chest, is determined by dividing the depth of the fore chest by its width and expressing the result as a ratio. Abdominal index shows the relation of the depth to width of paunch. It is calculated and expressed in a similar manner..

Slope of rump is a measurement of position rather than of dimension. It is the angle of inclination from the horizontal made by a line connecting the top of the hip point and the top of the pinbone. It may be measured with a clinometer or it may be calculated (by trigonometry) from measurements of the heights at hips and pinbones and the linear distance between these points. It is expressed in degrees.



Legginess is a term used to indicate the proportion of the total height that is below the under surface of the chest. It is calculated by subtracting the depth of fore chest from the height at withers, dividing the difference by the height at withers, and expressing the result in percent.

Head ratio is the relation of the total length of the head to its width at the eye level, expressed as a ratio. The number of pounds of live weight per centimeter of heart girth is also calculated.

The goats did not differ greatly from the cows in wedge shape for depth, width, or circumference; they were higher in thoracic index and a little higher in abdominal index. Legginess was considerably greater in the goats than in the cows, but head ratio was much lower. The marked difference between goats and cows in pounds weight per centimeter chest circumference was not unexpected in view of the three dimensional nature of body weight and the linear nature of chest circumference. The greatest difference in body form of the goats was in slope of rump which was four times that of Holstein cows and nine times that of Jersey cows. The various body proportions, ratios, and indexes, determined from average measurements, are shown in table 4.

TABLE 4.--Body characteristics and relationships in goats and cows

Body characteristics	Toggenburg goats	Holstein cows	Jersey cows
Wedge shape, depth.....ratio...	1.031	1.015	1.016
Wedge shape, width.....ratio...	1.519	1.410	1.532
Wedge shape, circumference...ratio...	1.181	1.169	1.199
Thoracic index.....ratio...	1.745	1.576	1.700
Abdominal index.....ratio...	1.185	1.134	1.127
Slope of rump.....degrees...	31.37	8.03	3.32
Legginess.....percent...	53.26	45.31	44.46
Head ratio.....ratio...	1.643	2.283	2.114
Chest circumferences....lb. per cm...	1.257	6.730	5.538

## COMPARISONS OF THE INTERNAL ANATOMY

The mean weights and body measurements for the internal organs and body parts of the female Toggenburg goats (New Mexico) are shown in comparison with the corresponding means for Holstein and Jersey cows (Beltsville) in table 5. In addition, the mean for each item from the goat data is expressed as percentages of the corresponding means for Holstein and Jersey cows. As in the case of external body measurements, the percentages were consistently higher in comparisons with Jersey means than with Holstein means. Because of the miscellaneous nature of the internal items grouping them for discussion was not feasible except in a few instances. The body weights shown are the ones obtained at the time the external body measurements were recorded because of variations in the elapsed time between final feeding and slaughter. The body weights obtained immediately before slaughter were used only in calculating empty body weight.

The goats were much smaller than cows in body mass. Percentages of Holstein and Jersey values were 8.3 and 11.1, respectively, for body weight, 8.2 and 11.0 for empty body weight, and 6.5 and 9.1 for carcass weight. As indicated by these figures, dressing percentage was much lower in the goats than in Holstein and Jersey cows.

Percentages of Holstein and Jersey values for thoracic cavity depth, width, and length averaged 45.7 and 51.3, respectively. These were within the range of the percentages for external measurements of body widths, depths, and lengths. Percentages for the two circumferences of the heart were of similar magnitude.

Percentages of Holstein and Jersey values for weights of blood, hide, and total stomachs were at essentially the same level as those for body weight and empty body weight. Percentages for weights of lungs and heart were slightly higher. Although percentages of Holstein and Jersey values for total stomach weight were at 9.0 and 11.8, respectively, and were similar to those for body weight, the percentages for some of the separate compartments were not. Percentages of Holstein and Jersey values for omasum weight were only 3.0 and 3.6, respectively, while those for reticulum weight, 16.6 and 20.2, respectively.

In processing the data for goats, a striking difference in the relative weights of the four stomach divisions was noted. In Holstein and Jersey cows the omasum was by far the second largest division. In goats the omasum was the smallest of the four. In actual weights the omasum represented only 9.3 percent of the total stomach weight in goats, compared to 28.2 and 30.5 percent for Holstein and Jersey cows, respectively. On the other hand, the weight of reticulum was 14.5 percent of the total stomach weight in goats compared with 7.9 and 8.5 percent for Holstein and Jersey cows. Abomasum weight was 15.9 percent of the total in goats compared with 11.9 and 13.3 percent for Holstein and Jersey cows.

Although Sisson and Grossman (6) gave no description of the anatomy of the goat they described the stomach of the sheep, another ruminant of similar size, as follows: "The omasum is much smaller than the reticulum,

TABLE 5.--A comparison of mean weights and body measurements for the internal anatomy of the female Toggenburg goats with those for Holstein and Jersey cows

Item of measurement	Average measurements			Ratio of			Values per 100 pounds of empty body weight			Ratio of	
	Toggenburg			Toggenburg			Toggenburg			Toggenburg	
	goats	Holstein	Jersey	goats	Holstein	Jersey	goats	Holstein	Jersey	goats to:	Holstein Jersey
Age.....year	7	7	7	cows	cows	cows	cows	cows	cows	cows	cows
Weight											
Body-ante mortem...lb.	111.29	1,343.00	1,001.00				123.22	122.89	121.64	1.003	1.013
Empty body.....lb.	90.32	1,092.88	822.93				100.00	100.00	100.00	1.000	1.000
Carcass.....lb.	43.64	667.62	477.96				48.32	61.09	58.08	.791	.832
Lungs (total).....g.	411.8	4,155.0	3,048.2				455.9	380.2	370.4	1.199	1.231
Heart I.....g.	264.6	2,231.7	1,642.0				293.0	204.2	199.5	1.435	1.469
Blood.....g.	2,458.5	27,796.6	19,482.1				2,722.0	2,543.4	2,367.4	1.070	1.150
Brain.....g.	108.0	427.9	414.0				119.6	39.2	50.3	3.051	2.378
Rumen.....g.	933.6	8,922.3	6,250.6				1,033.7	816.4	759.6	1.266	1.361
Reticulum.....g.	224.4	1,356.3	1,111.3				248.4	121.4	135.0	2.002	1.840
Omasum.....g.	144.4	4,867.1	3,996.2				159.9	445.3	485.6	.359	.329
Abomasum.....g.	246.7	2,050.3	1,746.4				273.1	187.6	212.2	1.456	1.287
Total stomach.....g.	1,549.1	17,245.9	13,104.5				1,715.1	1,578.0	1,592.4	1.087	1.077
Total intestine.....g.	1,435.9	9,629.9	7,738.4				1,589.8	881.1	940.3	1.804	1.691
Liver.....g.	895.6	7,280.3	6,150.8				991.6	666.2	747.4	1.488	1.327
Spleen.....g.	106.7	910.8	821.2				118.1	83.3	99.8	1.418	1.183
Pancreas.....g.	100.4	498.6	373.2				111.2	45.6	45.4	2.439	2.449
Kidney.....g.	166.4	1,381.7	963.5				184.2	126.4	117.1	1.457	1.573
Pituitary body.....g.	1.059	3.77	2.90				1.172	.345	.352	3.397	3.330
Pineal.....g.	.039	.31	.24				.043	.028	.029	1.536	1.483
Thyroid.....g.	6.305	35.85	28.60				6.981	3.280	3.475	2.128	2.009
Adrenals.....g.	4.859	33.73	27.42				5.380	3.086	3.332	1.743	1.615
Hide.....g.	2,993.8	32,908.7	25,061.4				3,314.7	3,011.2	3,045.4	1.101	1.088
Udder.....g.	757.4	17,341.1	14,315.6				838.6	1,586.7	1,739.6	.529	.482
Dressing.....pct.	39.21	49.71	47.75				-	-	-	-	-
Thoracic cavity											
Maximum depth.....cm.	24.18	50.70	46.80				26.77	4.64	5.69	5.769	4.705
Maximum length.....cm.	34.98	81.45	73.11				38.73	7.45	8.88	5.199	4.361
Width 7th rib.....cm.	17.81	38.30	32.80				19.72	3.50	3.99	5.634	4.942
Circ. heart (b).....cm.	22.89	51.02	45.46				25.34	4.68	5.52	5.415	4.591
Circ. heart (d).....cm.	27.77	59.09	53.73				30.75	5.41	6.53	5.684	4.709
Intestine lengths											
Small.....m.	22.39	48.08	45.66				24.79	4.40	5.55	5.634	4.467
Large.....m.	8.70	12.98	11.44				9.63	1.19	1.39	8.092	6.928
Total.....m.	31.09	61.05	56.98				34.42	5.59	6.92	6.157	4.974
Cross section area											
trachea.....sq.cm.	1.97	13.77	9.36				2.181	1.260	1.137	1.731	1.918



its capacity being only about one pint." They also stated that both the reticulum and abomasum are relatively larger than in the ox. Apparently, the stomach of the goat is similar to that of the sheep. The effect of these differences in the proportionate weights of the stomach divisions may have a significant bearing on the suitability of using goats in pilot studies of physiology and nutrition in cows.

Percentages of Holstein and Jersey values, respectively, were 14.2 and 15.0 for length of small intestines and 20.4 and 23.2 for length of large intestines. These percentages were considerably higher than those for total stomach, but they were only a third or half as high as those for heart circumferences, the other important linear measurements on internal organs.

In the group of abdominal organs composed of liver, spleen, pancreas, and kidneys, the percentages of Holstein and Jersey values ranged from 11.7 and 13.0, respectively, for spleen weight to 20.1 and 26.9 for pancreas weight. Percentages for these organs as a group were noticeably higher than those for empty body weight or total stomach weight. Percentages for the four endocrine glands were even higher. These percentages of Holstein and Jersey values, respectively, ranged from 12.6 and 16.3 for pineal weight to 28.1 and 36.5 for pituitary weight. These percentages for pituitary weight and the percentages for brain weight (25.2 and 26.1, respectively) were higher than those for any other internal weights.

Percentages of Holstein and Jersey values for udder weight (4.4 and 5.3, respectively) were lower than those for any anatomical item except omasum weight. This low value for udder weight may be explained by the results of studies by Turner and Reineke (8), which emphasized the rapidity and completeness of involution of the mammary glands in the goat after cessation of milking. In the present study, the majority of the goats used were either dry or in late lactation at the time the anatomical data were obtained.

Because empty body weight is the net weight of the total animal structure and is unaffected by the "fill" of the animal, the average for each of the post mortem items was converted to a value representing the number of units per 100 pounds empty body weight. These values (table 5) were used in making a more realistic appraisal of differences between the internal anatomy of the goats and of the cows.

For all but three items of measurement the values were higher for the goats than for either the Holstein or Jersey cows. Differences between these values for the goats and the cows can be more easily visualized by expressing the comparison for each item as a ratio of the value for the goat to that of the cow. As in the comparisons of external body measurements, ratios above 1.0 indicate relatively higher values and ratios below 1.0 indicate lower values for the goats than for cows.

These ratios of empty body weight values for the goats to those for Holstein and Jersey cows show that weights of carcass, omasum and udder were proportionally less in goats than in Holstein and Jersey cows. By



the same ratios three thoracic cavity measurements and two heart circumferences in goats were proportionally more than five times as great as those Holstein cows and nearly five times as great as those in Jersey cows. Items for which the goats had approximately twice the relative weight or measurement of Holstein and Jersey cows were the weights of reticulum pancreas, and thyroid and the length of large intestine. Items in which relative size was one- and one-half times as great in the goats were the weights of the heart, liver, kidneys, pineal, and adrenals, and the lengths of small intestines and total intestines. There was relatively little difference between the goats and Holstein and Jersey cows with respect to live weight, or the weights of total stomachs, blood, or hide.

The ratios for body weight indicate little difference in the average relative "fill" of the goats and Holstein and Jersey cows. An accurate comparison of the relative degree of fleshing of the goats and cows was not possible, but available photographs indicated that in most cases the goats were thinner in flesh than is considered desirable in the dairy cow. In view of the greater relative size of nearly all of the internal organs and the seemingly lower condition of flesh, the low dressing percentage of the goats is understandable.

#### SUMMARY

Measurements of the body form and internal anatomy of a group of 14 female Toggenburg goats were compared with corresponding measurements for 185 Holstein and 194 Jersey cows. Records of milk and fat production also were obtained. At the time of slaughter, the goats were on the average approximately 5 months older than the cows.

As a basis of comparison of the ante mortem data, the body measurements of the goats were expressed as percentages of the corresponding measurements of the Holstein and Jersey cows. In body weights the goats were only 8.3 and 11.1 percent of the Holstein and Jersey values, respectively. However, among the other measurements, the four body heights of the goats most nearly approached those of the Holstein and Jersey cows (50.9 and 56.4 percent, respectively). Percentages of Holstein and Jersey values, respectively, averaged 48.4 and 52.3 for six body lengths, 45.3 and 49.0 for three body depths, 44.3 and 48.1 for three body circumferences, 42.3 and 47.2 for three body widths, and 33.5 and 39.9 for widths of the pelvis. Percentages were especially high for lengths of loin and low for widths of loin and hips.

When compared on the basis of units of measurement per 100 centimeters of height at withers, the goats were almost the same as the cows in heights, except at the pinbones; they differed to the greatest extent in widths of loin and pelvis; they were relatively long in the loin; their heads were wide and short; they were low at the pinbones and short in the rump as measured on a horizontal plane.

The goats had greater wedge shape, especially in width; they were exceptionally deep in relation to width at the chest; they were more

"leggy;" and the slope of rump was 5 1/2 times as great as in the cows. The ratios of length to width of head was lower in the goats than in the cows.

The post mortem items of internal anatomy of the goats also were compared with those of cows and expressed as percentages. The percentages generally were lower than for the external body measurements with the exception of dimensions of the thoracic cavity and the circumferences of the heart. Comparisons were made also on the more realistic basis of units of weight or measurement per 100 pounds empty body weight. On this basis the goats were relatively low in weight of carcass and in the weights of omasum and udder. They were four and a half to eight times as great in lengths of small and large intestines; nearly five times as great in measurements of the thoracic cavity and in circumferences of the heart; nearly three times as great in brain and pituitary weights; about twice as great in weights of reticulum, pancreas, and thyroid and in length of large intestine; and about one and one-half times as great in weights of heart, liver, kidneys, pineal and adrenals, and in the lengths of small and total intestines. There was little difference with respect to body weight or the weights of blood, hide, or total stomachs.

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